Tapping Energy and Revenue Potential in Our Waste Streams

A Discussion of Anaerobic Digestion and Combined Heat and Power in MA

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Outline

- Focus of study
- Definition of terms
- History and State of anaerobic digestion in MA
- Case studies
- Challenges and associated solutions
- Takeaways

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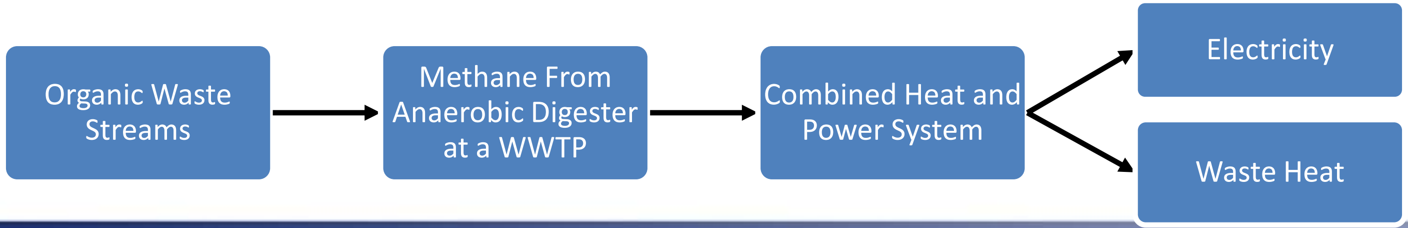
Why WWTPs?

- Wastewater contains ***10 times more energy*** than is needed to treat it, according to the Water Environment Research Foundation
- 30-60% of a city's energy bill is from water and wastewater treatment
- MA Energy Management Pilot at WWTPs demonstrated that great efficiencies can be achieved
- Food waste produces 3 x more methane than WW solids
- ***Organic Waste is an abundant and underutilized energy source!***

Intro: AD & CHP at WWTPs

- What is **Anaerobic Digestion (AD)**?
  - One method of energy recovery from organic materials through the breakdown of organic materials into gas comprised of 60-70% methane
- What is **Combined Heat and Power (CHP)**?
  - Conversion of a single fuel source into both electricity and useable heat
- Why **Wastewater Treatment Plants (WWTPs)**?
  - Have existing streams of unused organic wastes
- What are **organic wastes**?
  - Municipal wastewater solids, commercial or post-consumer food wastes, farm and agricultural wastes, yard and tree waste, etc.



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History of AD in MA

- Anaerobic digestion employed as early as the 1940s (Springfield, MA)
- Primarily a waste stabilization process, used in conjunction with *primary treatment.*
- Challenges emerged with the introduction of secondary treatment sludges in the 70s and 80s (1972 Clean Water Act)
  - Secondary sludges
  - Odors
  - Digester Side Streams (Supernatant)
- Facilities ultimately shut down their AD systems and opted for other methods of solids processing / disposal (i.e. incineration, composting, landfilling)

Status of AD and CHP in MA

- MA Facilities with digesters:

Operating AD and CHP	Operating AD without CHP	Have old AD structures that are not in use
Deer Island (MWRA) Pittsfield (just completed) Fairhaven (under construction)	Rockland Clinton (MWRA) Greater Lawrence	Springfield Brockton Leominster Northampton Ipswich Ware

- Imperfect knowledge about what is out there, but we're doing our best to capture the state of things in MA
- Non-municipal users of AD include:
  - Ken's Food in Marlborough, MA
  - Garelick Farms in Lynn & Franklin, MA
  - Coca-Cola in Northampton, MA
  - Rutland Farms in Rutland, MA (in the process of acquiring permits)

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Reason for Renewed Interest

- Energy recovery & GHG reductions
- Organic waste diversion from landfills
- EPA & DOE (through Lawrence Berkeley National Laboratory) have all been working on energy at WWTPs in the last 3-5 years
- Renewed interest has led to a resurgence of ideas, and the market is starting to pick up
- Literature is still lacking, but technology and possibilities are growing as well as the case studies demonstrating their financial and environmental benefits.

Why AD?

- Already being used effectively in MA and beyond
- Harnesses energy from organic wastes
- Onsite energy generation insulates facility from power and price fluctuations
- Reduced organic waste and sludge volumes and associated disposal costs
- Reduced GHG emissions as compared to traditional aerobic processes
- Allows for additional revenue streams (RECs, tipping fees, sale of electricity to grid, etc.)

Why Food Wastes at WWTPs?

- **Why Food Wastes at WWTPs?**
  - Enhances biogas production by three times
  - Diversion from landfills
  - **Supports existing goals of the Solid Waste Master Plan**
  - New revenue streams (e.g. tipping fees)
  - **An abundant and underutilized energy source!**

Potential Organic Waste Streams for Co-Digestion

- Fats, oils and greases (FOG)
- Food wastes
  - High strength organic waste (e.g. dairy whey, yogurt processing, etc.)
  - Pre-consumer / Source-separated organics
  - Post-consumer

Case Studies

- Each with a unique set of incentives and circumstances that made this possible and effective
  – Strass, Austria WWTP (10 MGD)
  – East Bay, CA Municipal Utility District (168 MGD)
  – Sheboygan, Wisconsin (18 MGD)
  – Essex Junction, VT (3.3 MGD)
  – Gloversville-Johnstown, NY (13 MGD)
  – MWRA Boston, MA (1313 MGD)
  – Pittsfield, MA (28.7 MGD)
  – Fairhaven , MA (5 MGD)

Strass in Zillertal, Austria Wastewater Treatment Plant

- Optimized plant operations (both AD methane production and overall energy efficiency) led to electricity production greater than needed onsite.
- Highly educated operators constantly continue to optimize process
- Advanced process analysis tools enabled optimizations

Facility Facts	
Design Flow	10 MGD
Average Flow	
CHP System Type	340kW co-generation engine
Percent of Total Energy Needs Generated On-Site	Over 100%

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East Bay, CA Municipal Utility District Wastewater Treatment Plant

- Decline in food processing industry → excess digester capacity
- Organics ban → "food" source for digesters / consistent local waste stream
  - Resource Recovery: Trucked Waste Program
  - *New revenue stream from tipping fees*
  - Patented food waste treatment process
  - Study demonstrated one ton of food waste produces 3 times more methane than one ton of municipal solids
- Currently receiving 20-40 tons/day food waste (1-2 trucks per day), but has capacity for 300 tons/day

Facility Facts	
Design Flow	168 MGD
Average Flow	75 MGD
CHP System Type	3 x 2.15 MW engine
Percent of Total Energy Needs Generated On-Site	90%

Example of a 20 ton truck

http://www.coffmanstone.com/delivery.asp

Sheboygan, Wisconsin Wastewater Treatment Plant

- 2002-2008 natural gas price and electricity rate increased 75-100%
- Partnership with local power utility that installed and owns the majority of the system
- Facility purchases energy from utility, and utility pays SWTTP to monitor the system
- Biogas production optimized 90% by adding high strength organic wastes (cheese) directly to digester
- SWWTP sells RECs for additional revenue
- 2 x 200kw turbines to be installed in 2010 with $205,000 Focus in Energy Grant. 90-100+% of total energy needs anticipated

Facility Facts	
Design Flow	18.4 MGD
Average Flow	11.8 MGD
CHP System Type	10 x 30kw microturbines
Percent of Total Energy Needs Generated On-Site	35-50%
Cost of the cogeneration system	$1.2 M
Cost of system to Sheboygan	$200,000

http://www.g...jwastewater.com/images/arial-3.jpg

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Village of Essex Junction, VT Wastewater Treatment Plant

- A willing manager
- Interest in innovation
- Batch feeding high strength food waste and fats, oils and grease (FOG)
- Received monetary incentives to improve payback (Efficiency Vermont, Biomass Energy Resource Center, Native Energy, Department of Energy Region 1)
- 6.8 year payback with incentives

Facility Facts	
Design Flow	3.3 MGD
Average Flow	2.0 MGD
CHP System Type	2 x 30kW Microturbines
Percent of Total Energy Needs Generated On-Site	37-39%
Total Capital Cost	$303,000

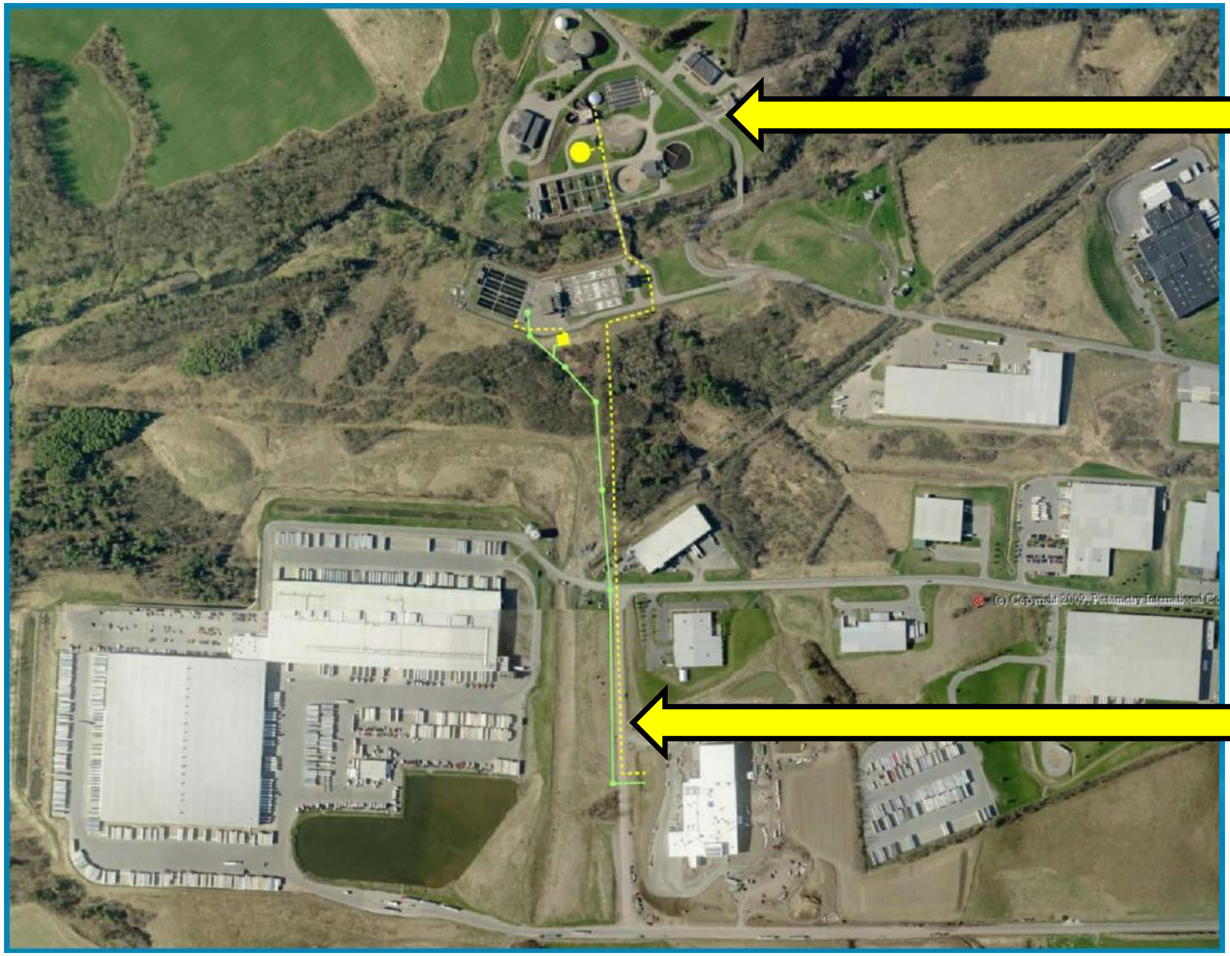
AD, CHP and additional organic waste streams are all possible at *small* WWTPs!

Gloversville-Johnstown, NY Wastewater Treatment Plant

- Excess capacity from decline of industrial manufacturing base
- Rising electricity prices
- Proximity of dairy waste producers for a steady input of high strength food waste (uses approximately half of digester capacity) and annual tipping fee revenue of 1.3 million
- NYSERDA (New York State Energy Research and Development Authority) funded project to improve existing digesters and biogas storage and add more CHP
- Anticipating production of electricity in excess of facility needs
- Has effectively managed its side streams and secondary sludge through process adaptations

Facility Facts	
Design Flow	13 MGD
Average Flow	6.5-7 MGD
CHP System Type	2 x 350kW engines
Percent of Total Energy Needs Generated On-Site	100% Anticipated
Total Capital Costs	$9.5M
Engine Generator Upgrade Cost	$3M

Gloversville-Johnstown, NY
Johnstown Industrial Park



Gloversville-Johnstown WWTP

Industries:
- Fage Yogurt
- Cappiello Cheese
- Euphrates Cheese

Direct pipeline to WWTP

MWRA Deer Island
Wastewater Treatment Plant

- Current system built 1995-1998
- Funded through bonds and some federal and state assistance
- 12 Egg-shaped digesters, 3 million gallons each
- 65% volatile solids reduction, 55% total solids reduction through AD

Over 70% excess capacity!

Facility Facts	
Design Flow	1313 MGD
Average Flow	365 MGD
CHP System Type	3.28 MW steam turbine generator
Percent of Total Energy Needs Generated On-Site	17.7%

http://www.mwra.state.ma.us/harbor/html/soh_1.htm

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City of Pittsfield, MA
Wastewater Treatment Plant

- Clean Energy Center / Massachusetts Technology Collaborative grant for feasibility study
- $16 million stimulus grants through the Clean Water State Revolving Fund
- Upgrade of existing digesters
- Considering the addition of FOG
- Project demonstrates potential for *positive cash flow* in its first year of operation

Facility Facts	
Design Flow	17 MGD
Average Flow	12 MGD
CHP System Type	3 x 65kW microturbines
Percent of Total Energy Needs Generated On-Site	29%

City of Pittsfield, MA
Wastewater Treatment Plant (17 MGD)

Anaerobic Digestion Upgrade (195 kW)

- Investment: $1.67M
- Est. annual energy savings: $206,000 (29%)
- Simple Payback: 8.0 years

Look at it on a Cash Flow ($) basis

- Apply annual energy savings to pay for loan debt (10 yr loan@2% & 3% annual rise in electricity costs)

Annual Energy Savings		REC Revenue		Annual Loan Payment
$206,000	+	**$45,000**	-	**$184,395**

= $66,605 Positive Cash Flow!

Making $$!

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Fairhaven, MA
Wastewater Pollution Control Facility

- $7.9M SRF Green Infrastructure Grant (through ARRA for AD+CHP and 3 solar panels), $7.2M lowest bid
- New installations of both AD and CHP
- Considering impact of incorporating additional organic waste streams, with a focus on *local* FOG collection to avert local system backups
- Demonstrates importance of financial incentives
- Suggests that **feasibility studies** play a significant role in public acceptance

Facility Facts	
Design Flow	5 MGD
Average Flow	2.7 MGD
CHP System Type	1 x 110 kW, 1 x 64 kW internal combustion engines
Percent of Total Energy Needs Generated On-Site	26% (initially), 73% (after phase-in of other organic waste)
Total AD + CHP Cost	$7.2M

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Fairhaven Payback Schedule

- Anticipated system cost: $7.2M
- Fairhaven's feasibility study showed payback:
  - With WWTP solids and FOG: over 30 years
  - With WWTP solids waste, FOG and phased-in high strength food waste (liquid wastes such as beverage and dairy waste): 13 years

Food waste additions can dramatically improve payback!

Financial Challenges

- Costs – preliminary assessments, design, construction
- Financing
- Interconnection costs (regulators can facilitate this process)

Funding Opportunities

- Leases
- Financing
- State or Federal Grants
- Private / NGO Grants (National Grid, Clean Energy Center)
- Bonds
- Renewable Energy Credits
- A Facility's Own Expanded Revenue Streams

Technical Challenges

- Odor control
- Space constraints
- Methane fuel conditioning (removal of corrosive contaminants) for conversion to electricity and heat
- Processes that have the flexibility to adapt to new and increasingly stringent regulatory requirements
- Process changes (e.g. food waste slurrying and sludge mixing)
- Limited information regarding domestic vendors and expertise for AD and CHP technologies
- Treatment and disposal of activated (bacterially treated) sludge
- Potential toxicity of by product if used for land application

Technological Advances

- Historical challenges have been addressed:
  - AD *limits* odors as an airtight process
  - CHP further controls any methane odors
  - De-nitrification aids with supernatant quality
  - Processes are now better adapted to manage secondary sludge and strong side streams
- Constantly advancing technologies for greater efficiencies including: mixing and digester design, digestion additives, cell lysis, fuel conditioning, etc.

Operational Challenges

- Municipalities asked to work outside of core competency – treating waste water
- Conveyance of new waste streams to wastewater treatment facilities
- New operation and maintenance procedures
- Resistance because of :
  – past history with AD
  – process changes when existing systems function well with possible process upsets from the new system

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Operational Support

- Learning / Training from operators of successful facilities (plant tours, workshops, etc.)
- Additional training for process optimization (similar to Strass, Austria)
- Central Tech support for AD in MA

Political Challenges

- Decision-maker buy-in
- Site use changes
- Community impacts and concerns (such as increased truck traffic, odors, health, etc.)
- Public acceptance

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Regulatory Challenges

- Myriad of permits can be conflicting, complicated to navigate and stall project advancement (siting permits, emissions permits, land application permits, water discharge permits, etc.)
- Stringent water discharge permit requirements (e.g. phosphorous and nitrogen limits) preclude consideration of AD for fear of implications on effluent quality / nutrient loading

Regulatory Opportunities

- Can we make our regulations align properly to encourage a beneficial practice instead of discouraging it?
- Can we make interconnection easier?

Takeaways

- MA has underutilized waste streams
- Wastewater has 10 times more energy than is needed to treat it
- Incorporation of additional organic waste streams can significantly boost the environmental and economic benefits of using AD and CHP
- If we look more broadly at our waste streams, we can begin to envision the potential regional solutions and the opportunities for multi-faceted initiatives.

Building Organics Capacity

Task Force on Building Organics Capacity

http://www.mass.gov/dep/public/committee/adtf

To help develop recommendations for overcoming barriers to the siting and development of:

- additional anaerobic digestion, composting and recycling capacity in Massachusetts.

Questions? Would like to be added to the mailing list?

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